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# An optogenetic approach for investigation of excitatory and inhibitory network GABA actions in mice expressing channelrhodopsin-2 in GABAergic neurons

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## Abstract

© 2016 the authors.To investigate excitatory and inhibitory GABA actions in cortical neuronal networks, we present a novel optogenetic approach using a mouse knock-in line with conditional expression of channelrhodopsin-2 (ChR2) in GABAergic interneurons. During whole-cell recordings from hippocampal and neocortical slices from postnatal day (P) 2-P15 mice, photostimulation caused depolarization and excitation of interneurons and evoked barrages of postsynaptic GABAergic currents. Excitatory/inhibitory GABA actions on pyramidal cells were assessed by monitoring the alteration in the frequency of EPSCs during photostimulation of interneurons. We found that in slices from P2-P8 mice, photostimulation evoked an increase in EPSC frequency, whereas in P9 -P15 mice the response switched to a reduction in EPSC frequency, indicating a developmental excitatory-to-inhibitory switch in GABA actions on glutamatergic neurons. Using a similar approach in urethane-anesthetized animals in vivo, we found that photostimulation of interneurons reduces EPSC frequency at ages P3-P9. Thus, expression of ChR2 in GABAergic interneurons of mice enables selective photostimulation of interneurons during the early postnatal period, and these mice display a developmental excitatory-to-inhibitory switch in GABA action in cortical slices in vitro, but so far show mainly inhibitory GABA actions on spontaneous EPSCs in the immature hippocampus and neocortex in vivo.

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## Keywords

ChR2, Cortex, GABA, Hippocampus, Inhibition, Interneurons, Optogenetics, Patch clamp